Crawling from a Nutrient-laden Quagmire

Jeff Ostermiller, et al.
Utah Division of Water Quality

Presentation Outline

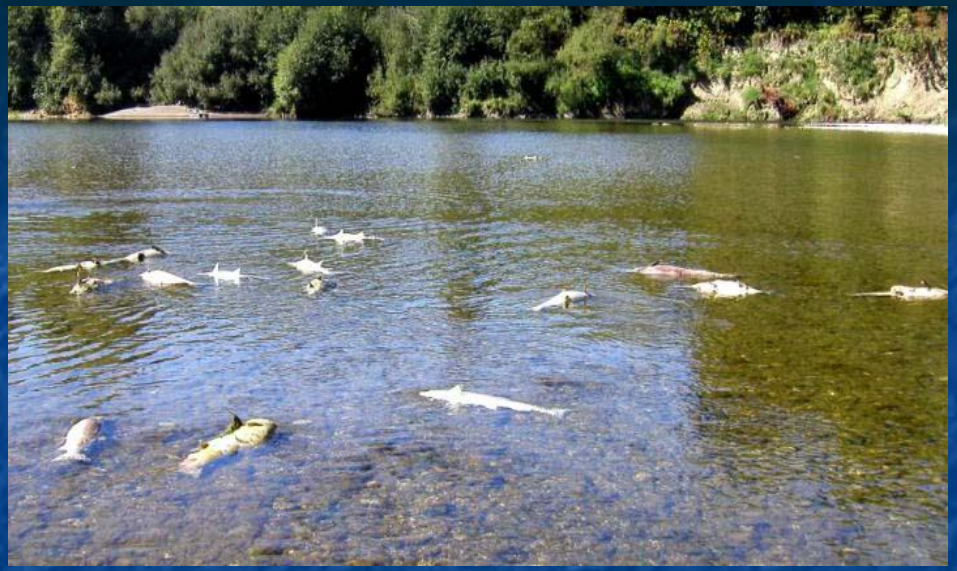
- Concerns with Nitrogen and Phosphorous Pollution
- The Political Landscape
- Utah's Proposed Approach for Addressing Excessive Nutrients
- Preliminary Results
- Implementation Considerations

Nutrients: Why Do We Care?

- Over-fertilization of water bodies is a widespread problem nationally
- Beneficial uses become impaired especially due to low dissolved oxygen which is choking our water bodies
- Phosphorus and/or Nitrogen are sources of many impairments

Nuisance Algae

- Unpalatable as food source, alters ecosystem health and can alter food webs
- Increases costs from treating drinking water
- Toxic for fish, wildlife, pets and livestock
- Human health concerns: rashes, liver damage, long-term neurological effects
- Traps sediment in streams, which alters habitat

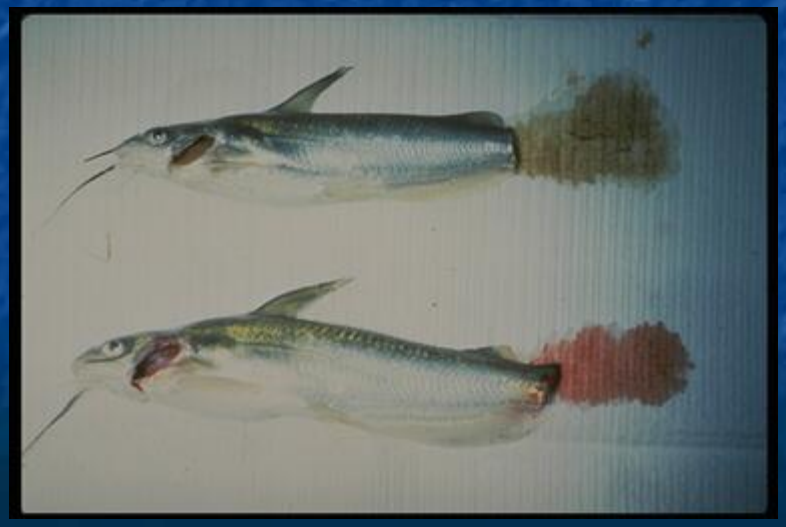


Fish kill as a result of low dissolved oxygen

Mycrocystis bloom in Matt Warner Reservoir
18 cows died
September, 2004;
reoccurrence in 2010

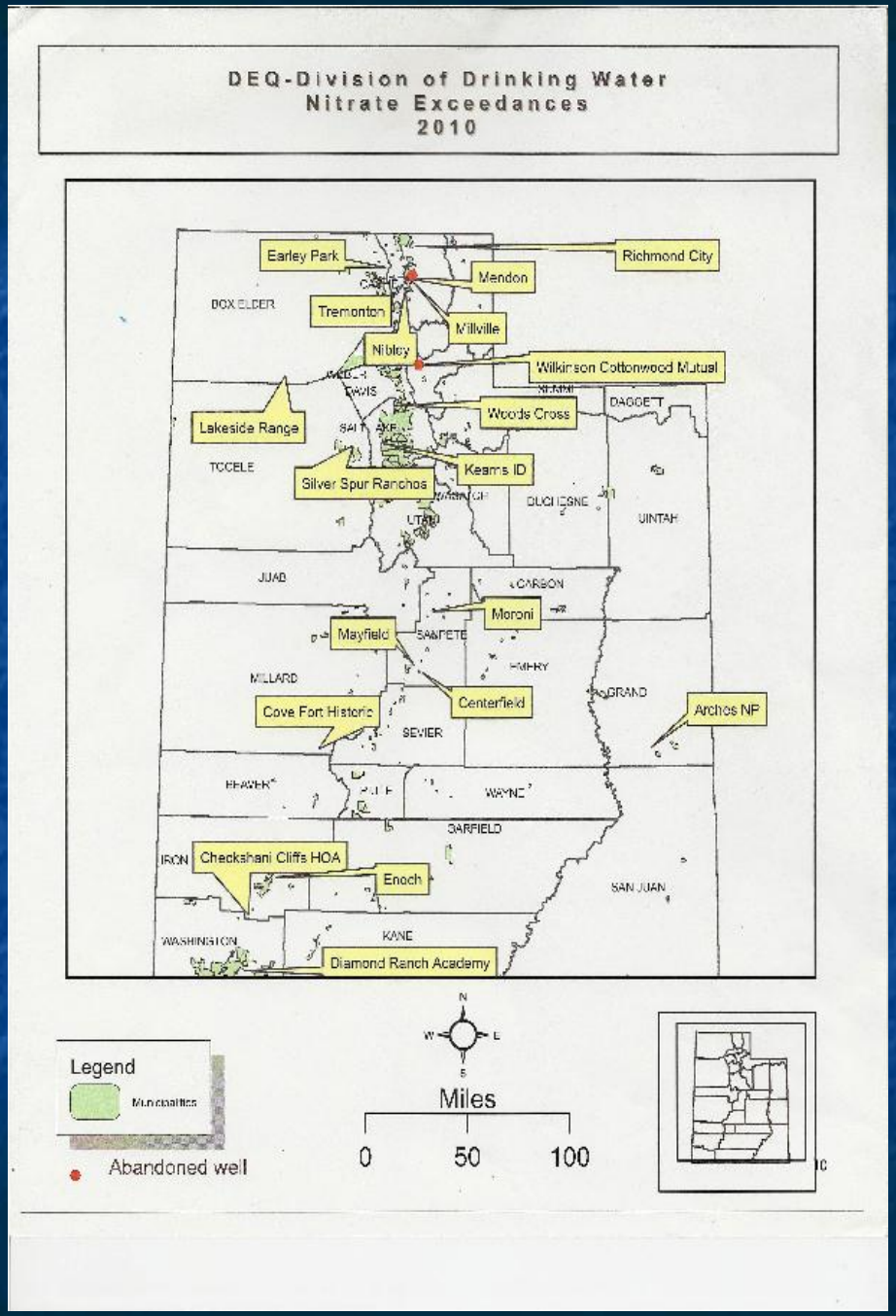
Nitrate/Nitrite Toxicity

Blue Baby Syndrome

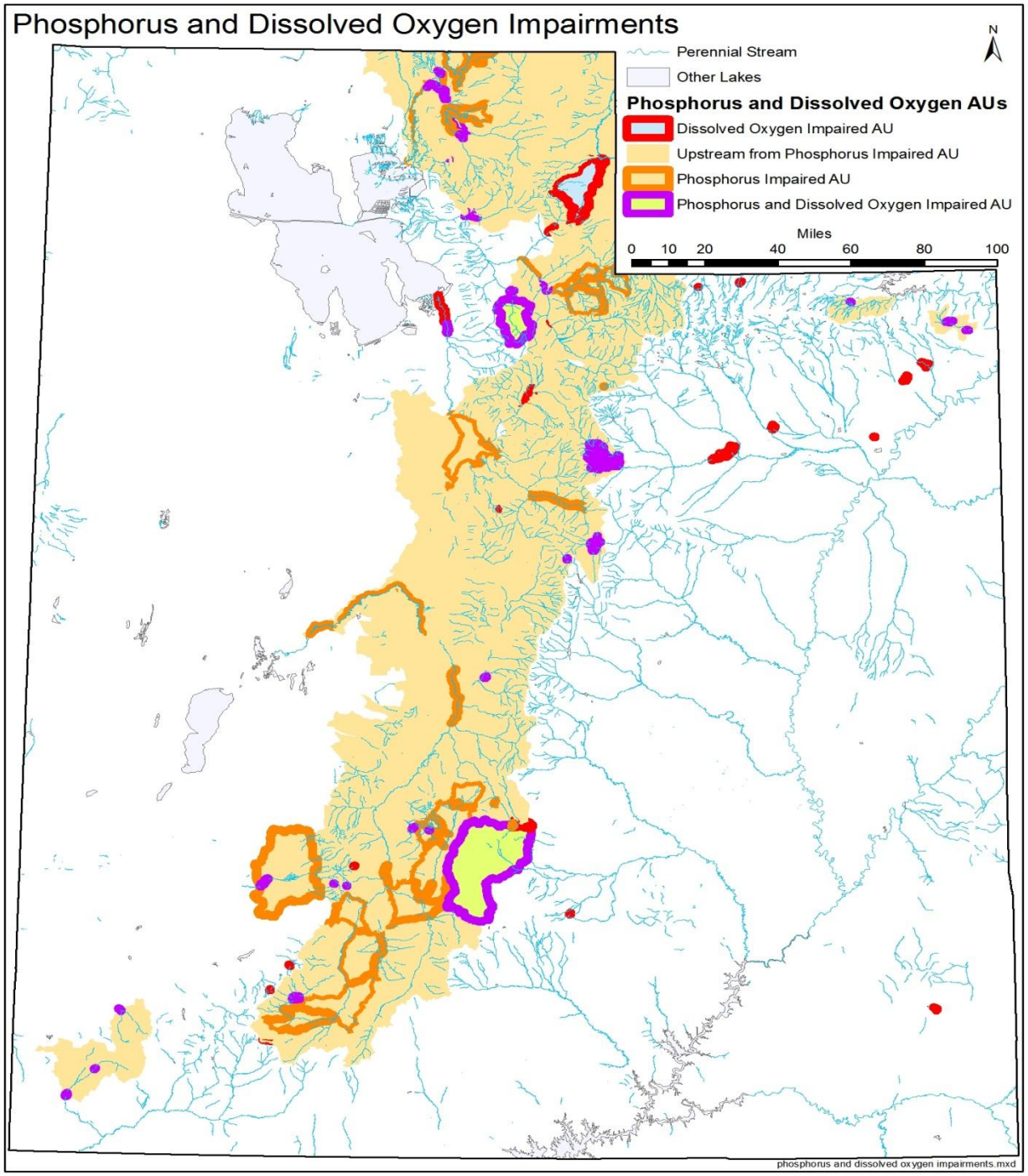


Brown Blood Disease

- Methemoglinemia
- Nitrite binds with hemoglobin, forming methemoglobin which cannot carry oxygen



Nitrate Exceedances in Utah Public Drinking Water Wells



Spatial extent of nutrient-related surface water impairments

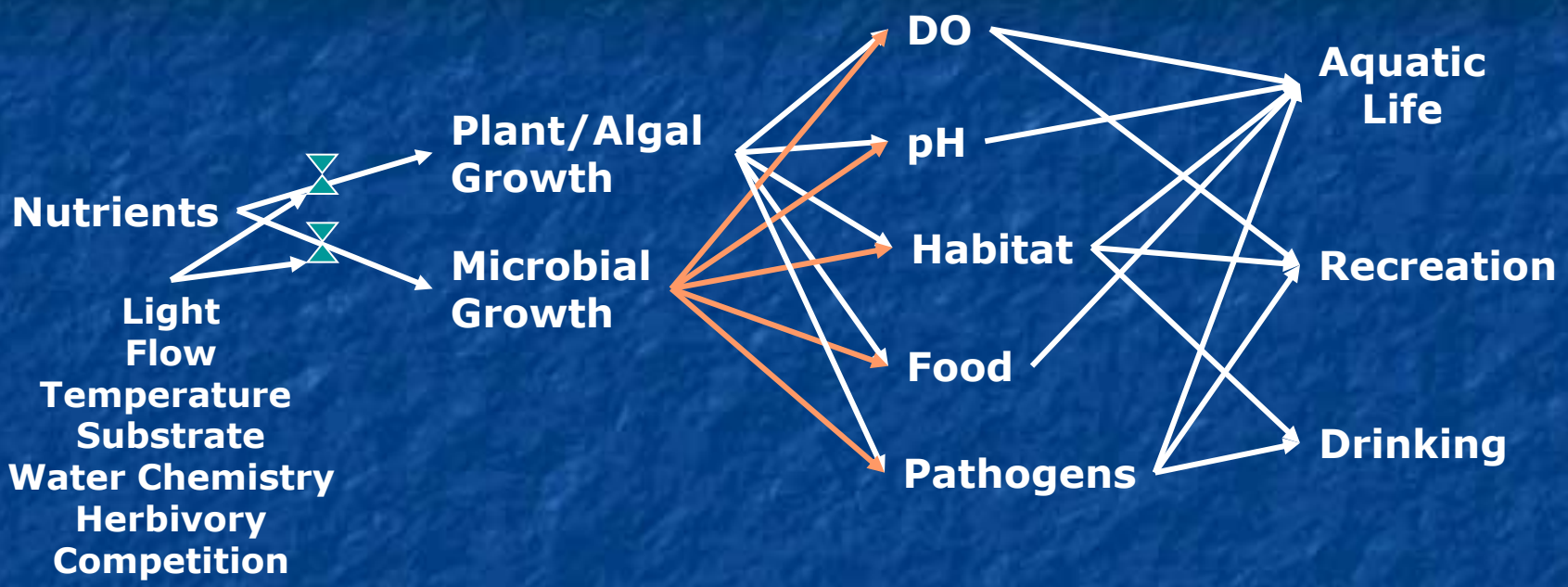
Currently addressed with phased TMDLs

Nutrients: Potential Sources

- Agriculture without proper use of BMPs
- Urban runoff
- Wastewater treatment facilities
- Industrial facilities
- Excessive fertilizer application
- Wildlife

Many have a stake in nutrient-related water quality programs!

Complex Linkages Between Nutrients and Uses



- Interactions among intermediary pathways are interactive, non-linear, and often site-specific.

A Divisive Political Climate

- Numeric Criteria: A National EPA Priority
  - Legal Challenges: both for criteria and against
  - Increasing Problems at National Scale (e.g., Gulf Hypoxia)

- Disconnect between ecological needs and wastewater treatment technologies
  - Few established programs in regulations to address concerns
  - Plant upgrades are challenging

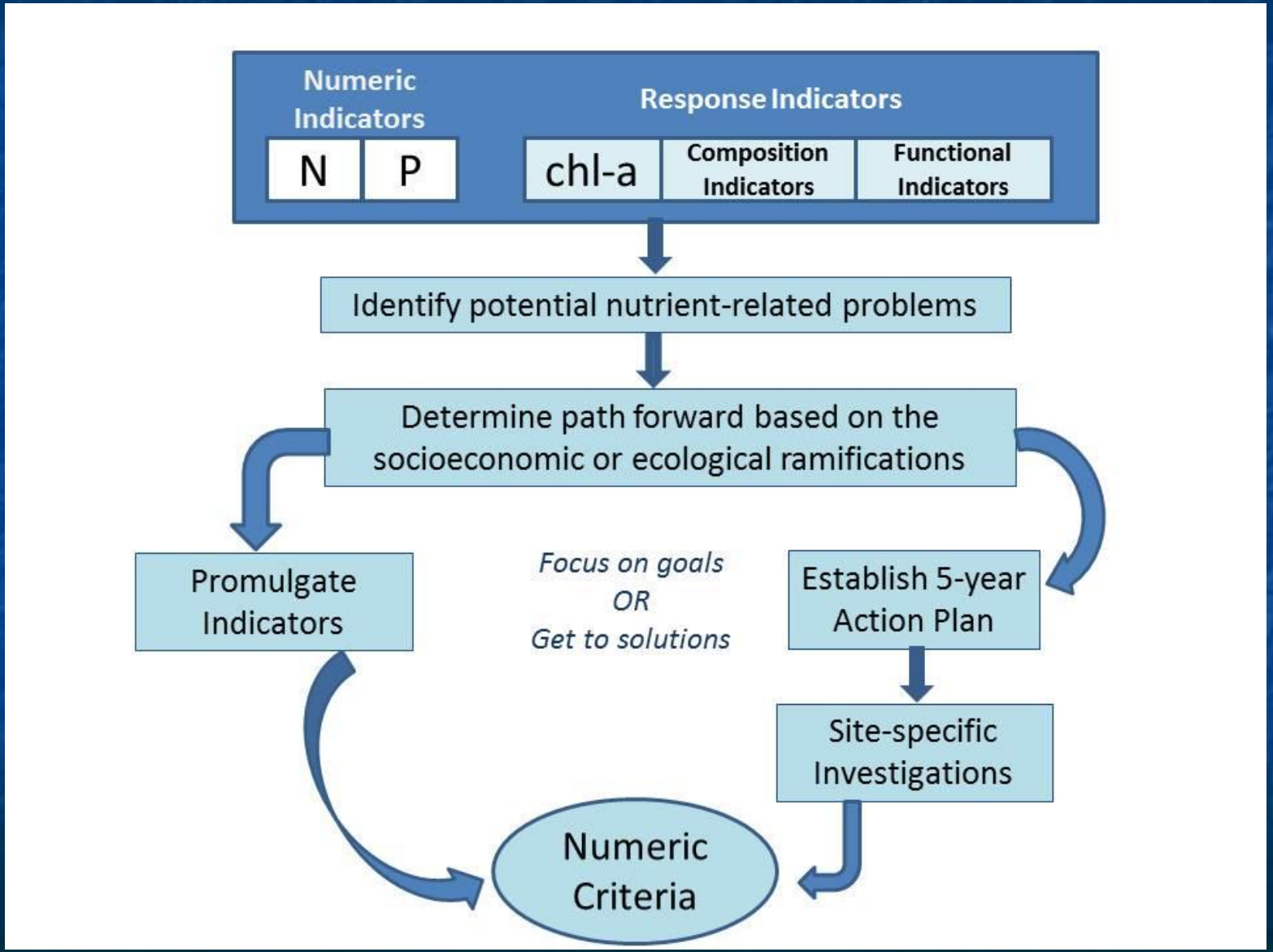
- CWA programs aimed at toxics do not always translate to non-toxics

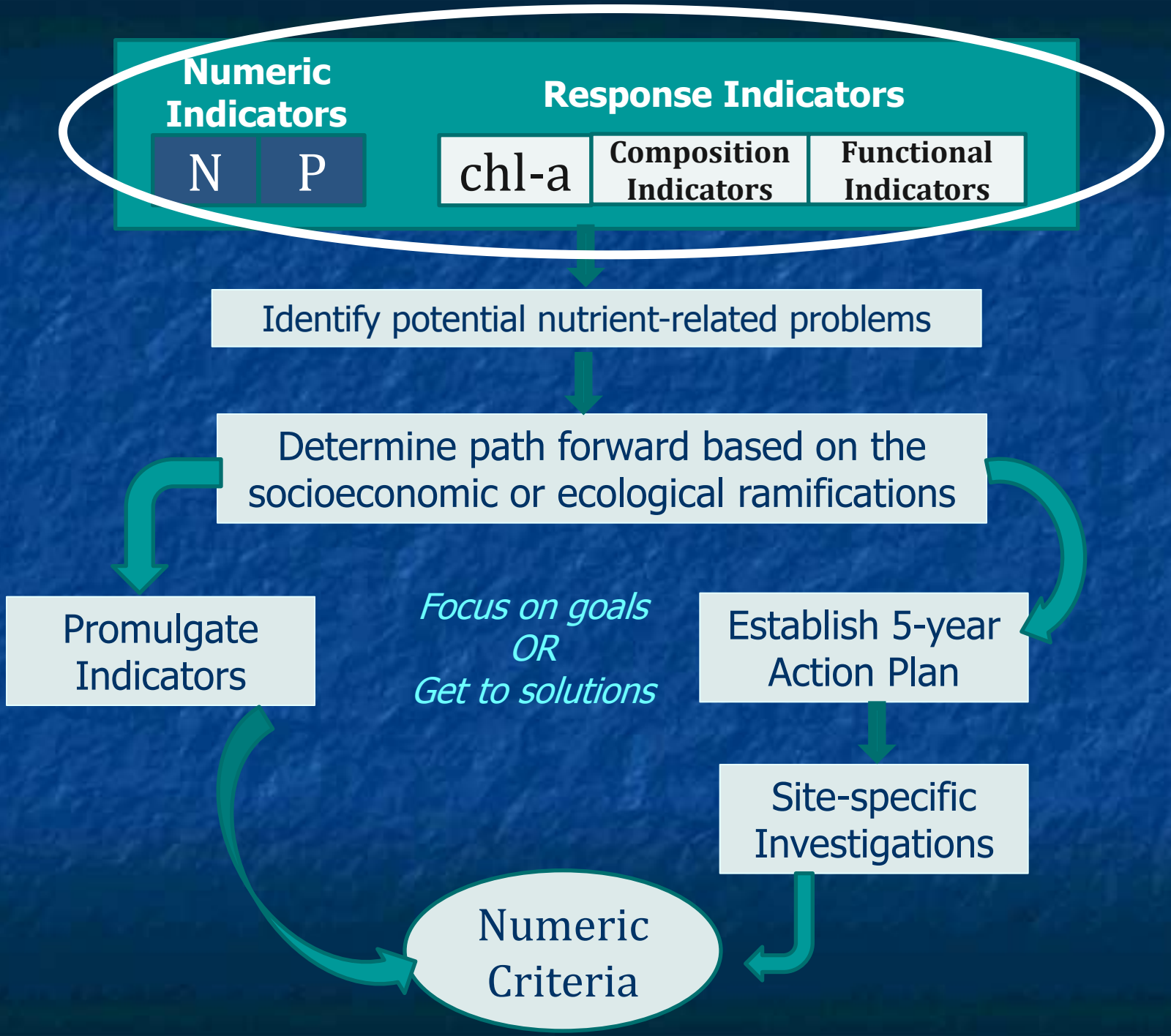
- Result: over 50% of CWA lawsuits, ~10 in FL alone

Why do issues surrounding nutrients have to be so divisive?

- What criteria are necessary to protect beneficial uses?
- How can we equitably implement nutrient-reduction programs to maximize cost:benefit?
- Can we work together to avoid the legal skirmishes occurring elsewhere?

Utah's Draft Approach: The 10,000' Level



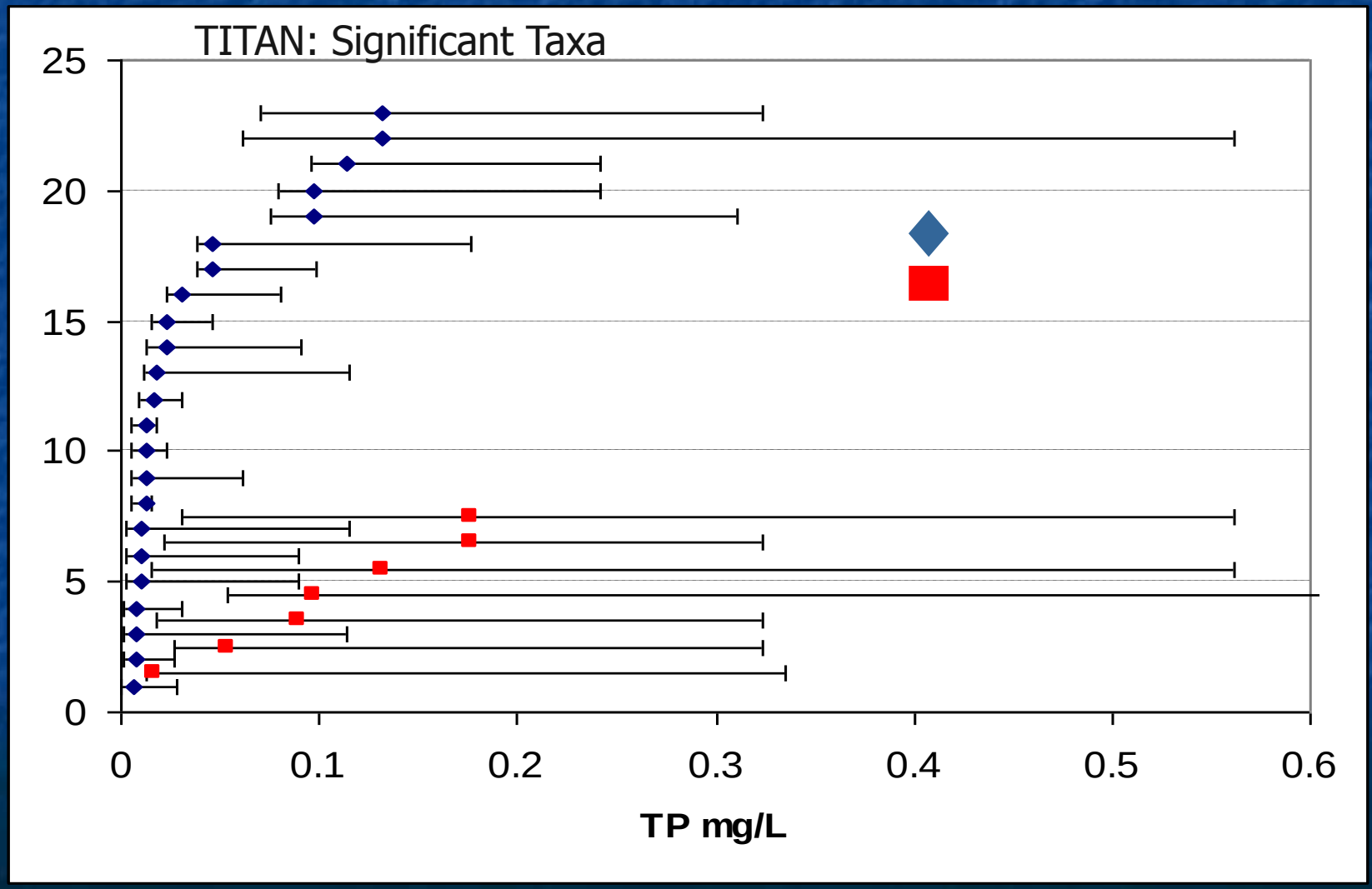

Numeric Indicators
N
P
Response Indicators
chl-a
Composition Indicators
Functional Indicators
Identify potential nutrient-related problems
Determine path forward based on the socioeconomic or ecological ramifications
Promulgate Indicators
Focus on goals
OR
Get to solutions
Establish 5-year Action Plan
Site-specific Investigations
Numeric Criteria

Biological Indicators of Stream Condition

- Biological data—diatoms and macroinvertebrates—to assess biological degradation
- Clear(er) ties to aquatic life uses
- Development of stressor-specific nutrient tolerance values

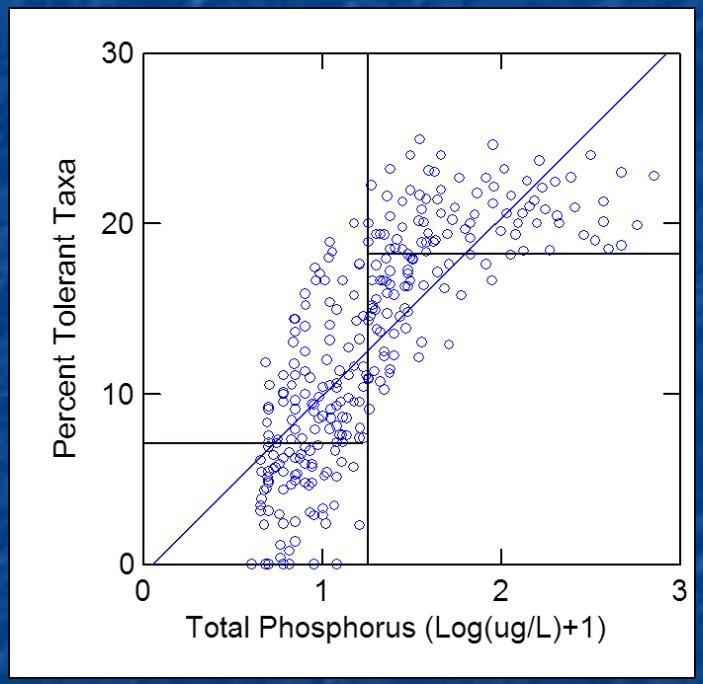
We need methods of identifying deleterious biological effects before impairment occurs.

Development of Nutrient-Specific Indicators



Regional N & P Indicators

Preliminary Values from Macroinvertebrate Thresholds



TP

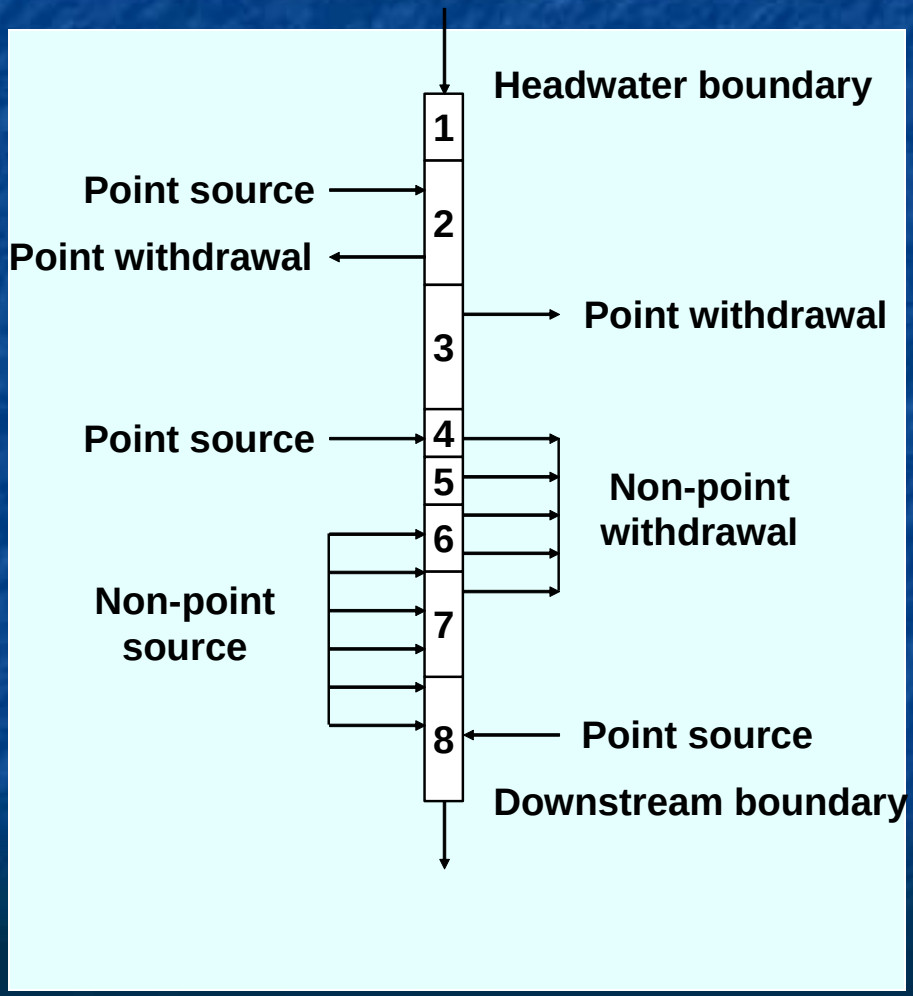
- Values ranged from 0.04 to 0.60 mg/l
- A criterion of ~0.05 mg/l is most defensible

N

- Values ranged from 0.1 to 1.2 mg/l
- Potential criteria range from 0.3 to 1.0 mg/l

Collaboration with Mike Paul, Tetra Tech

Mechanistic Models



- Developed for each POTW
- Allows predictions of future scenarios
- Evaluates interaction among nutrient-related water quality parameters
- Captures causal linkage between high nutrients and biological deradation

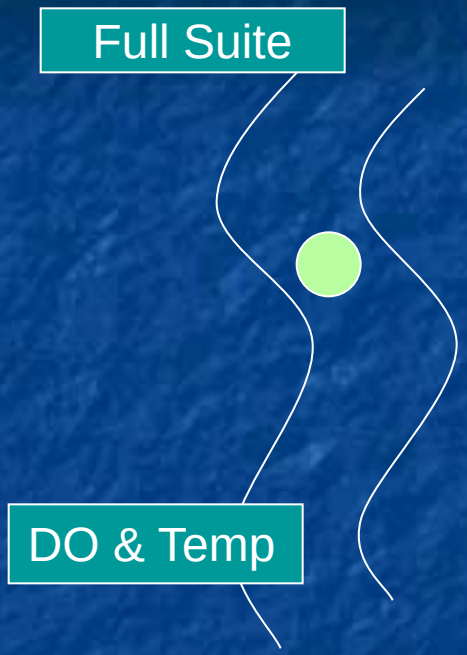
Collaboration with B. Neilson and A. Hobson, USU

Functional Indicators of Stream Conditions

- Develop field, laboratory, and analytical methods
- Use collections across nutrient gradients to put results in greater perspective.
- Examples: organic matter standing stock, ecosystem metabolism, nutrient limitation, and leaf pack decomposition.

Collaboration with M. Baker (USU)

Ongoing Investigations

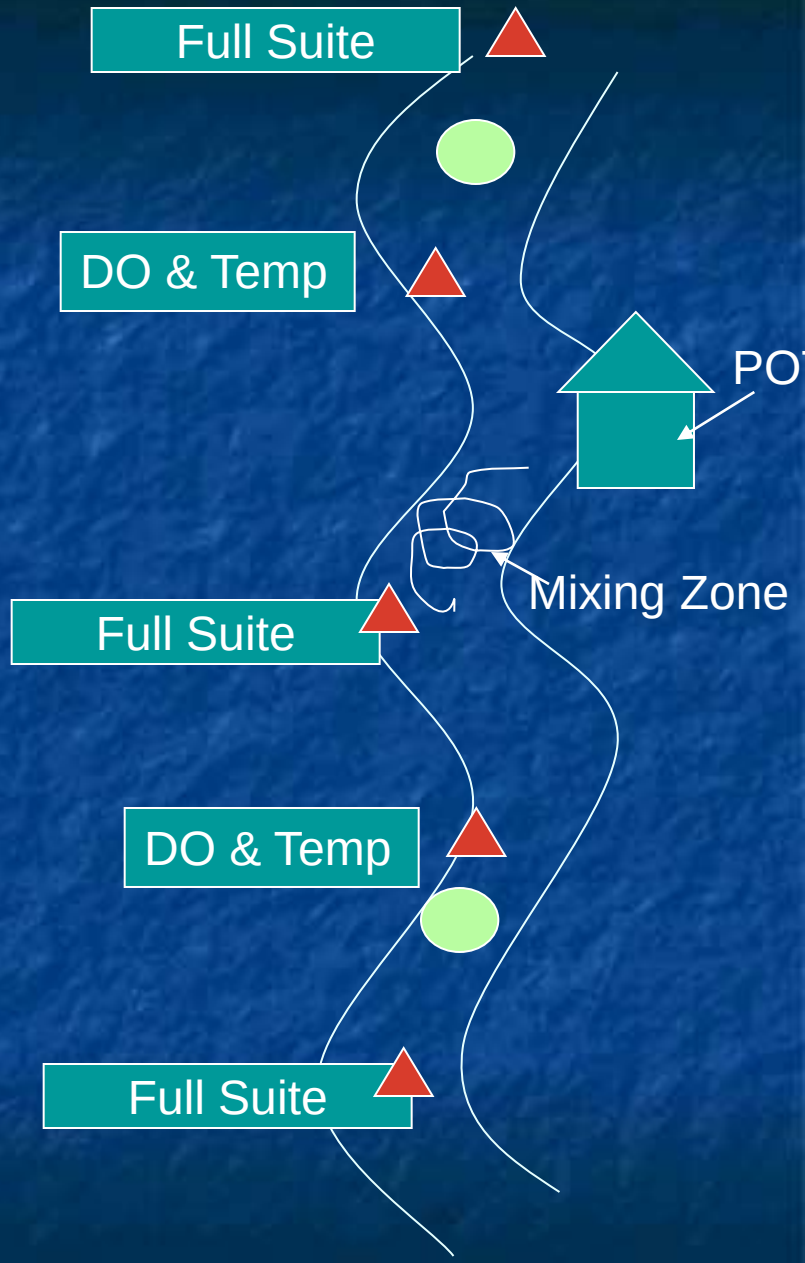


17 Reference Sites

Numerous biological, chemical, and physical parameters were measured on several occasions.

Data analysis and processing is underway.

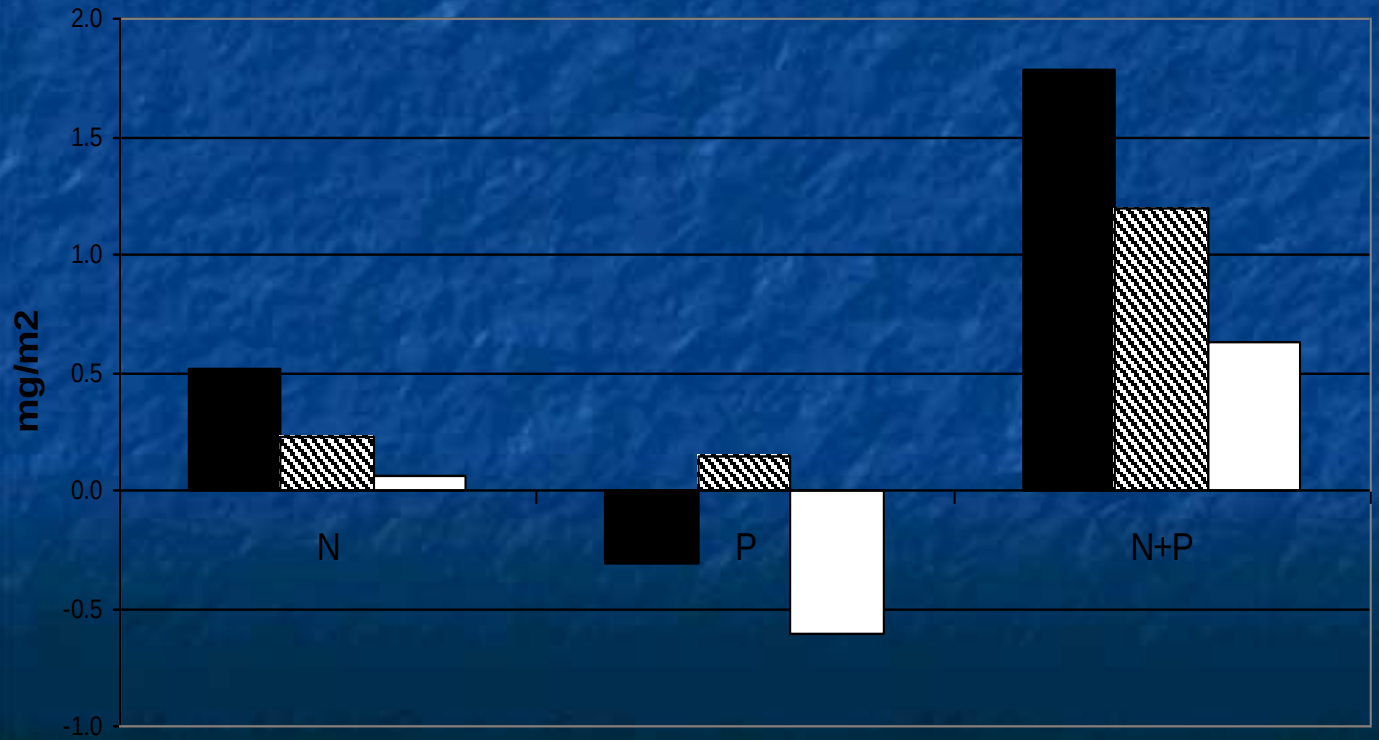
Follow-up visits are planned for this summer.



9 POTWs

Limiting Nutrients

Preliminary Results



Limiting Nutrients

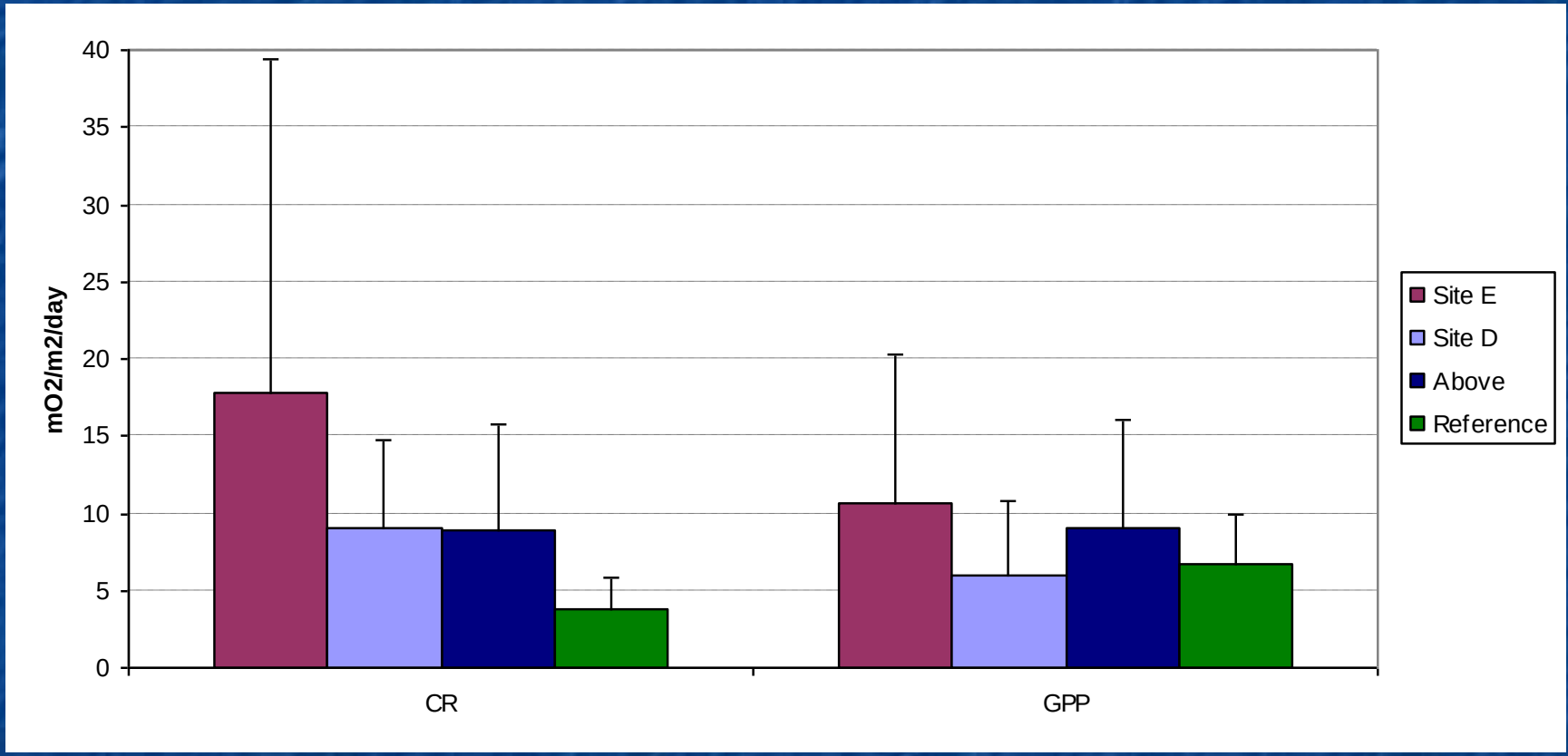
Preliminary Results

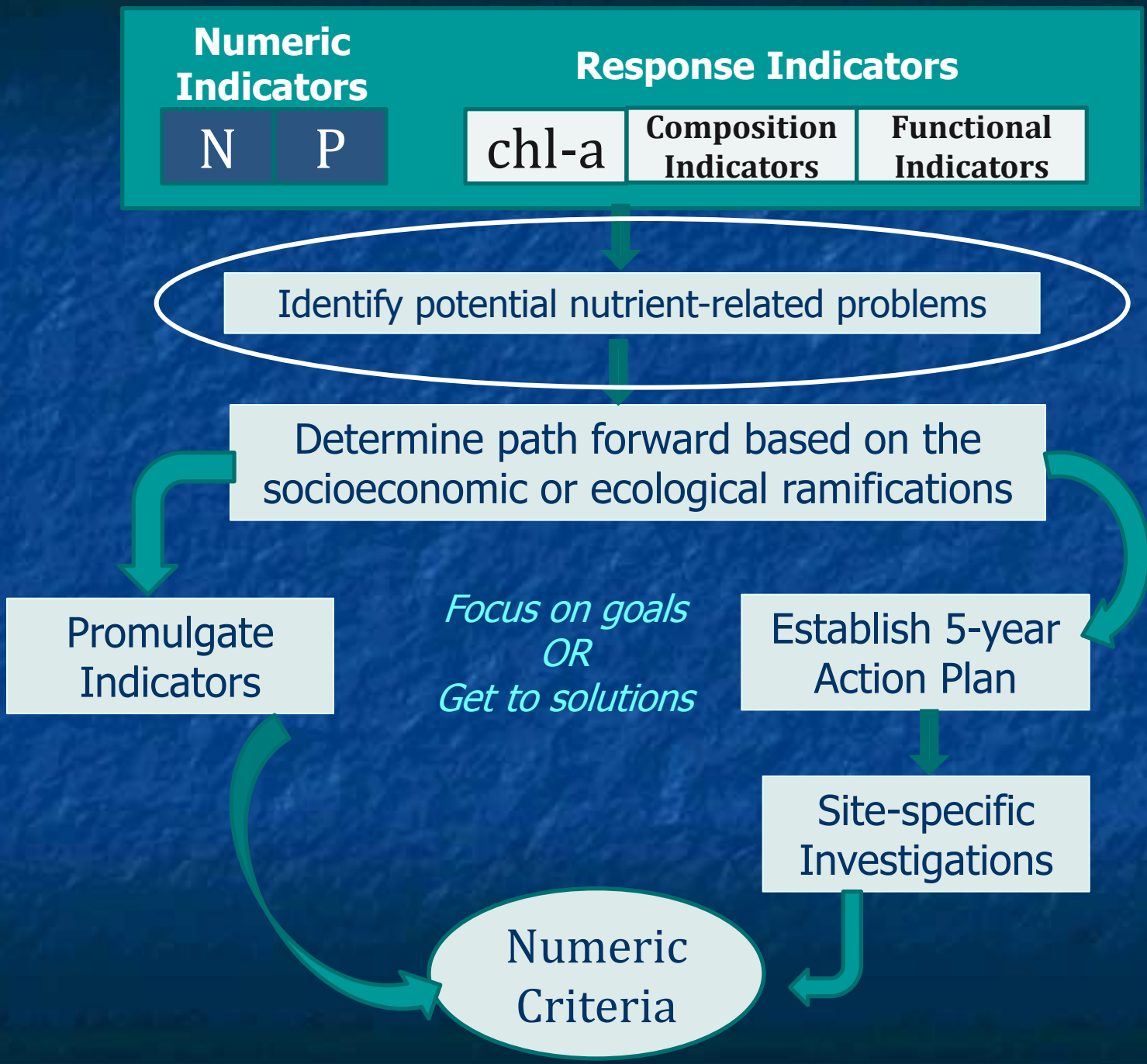
Reference Sites	Not Limited	N	P	N+P
n=15	4	4	0	9
% of Sites	27	27	0	60

A Couple of Examples

Treatment Sites	Limitation	
	Above	Below
Silver Ck @ Snyderville	N&P	Not Limited
Little Bear R @ Wellsville Lagoons	N	Not Limited

Stream Metabolism

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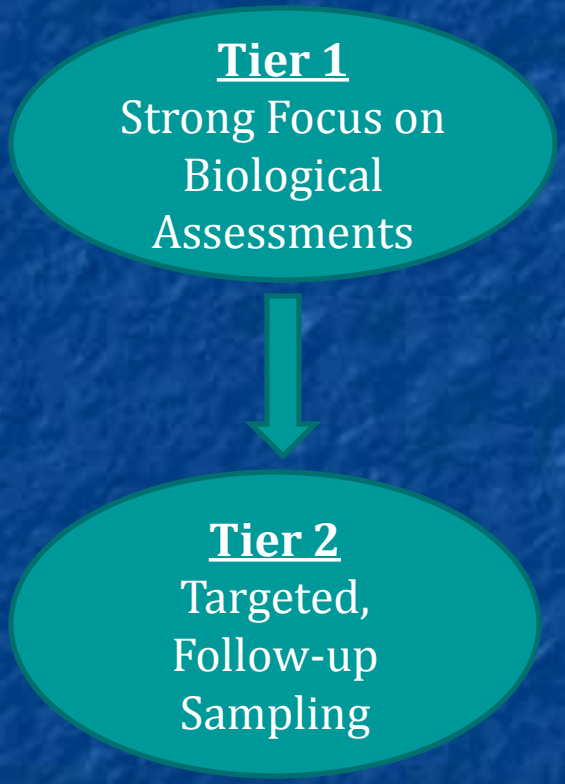
Monitoring and Assessments

Tiered Monitoring Approach



Tier 1

- Routine monitoring
- Less resource intensive
- Provides screening data

Tier 2

- Used for assessment decisions
- More intensive collections
- Minimize assessment errors

Monitoring and Assessment

Nutrient-specific Tier 2 Assessments

Chemical & Biological/Functional

- Impaired

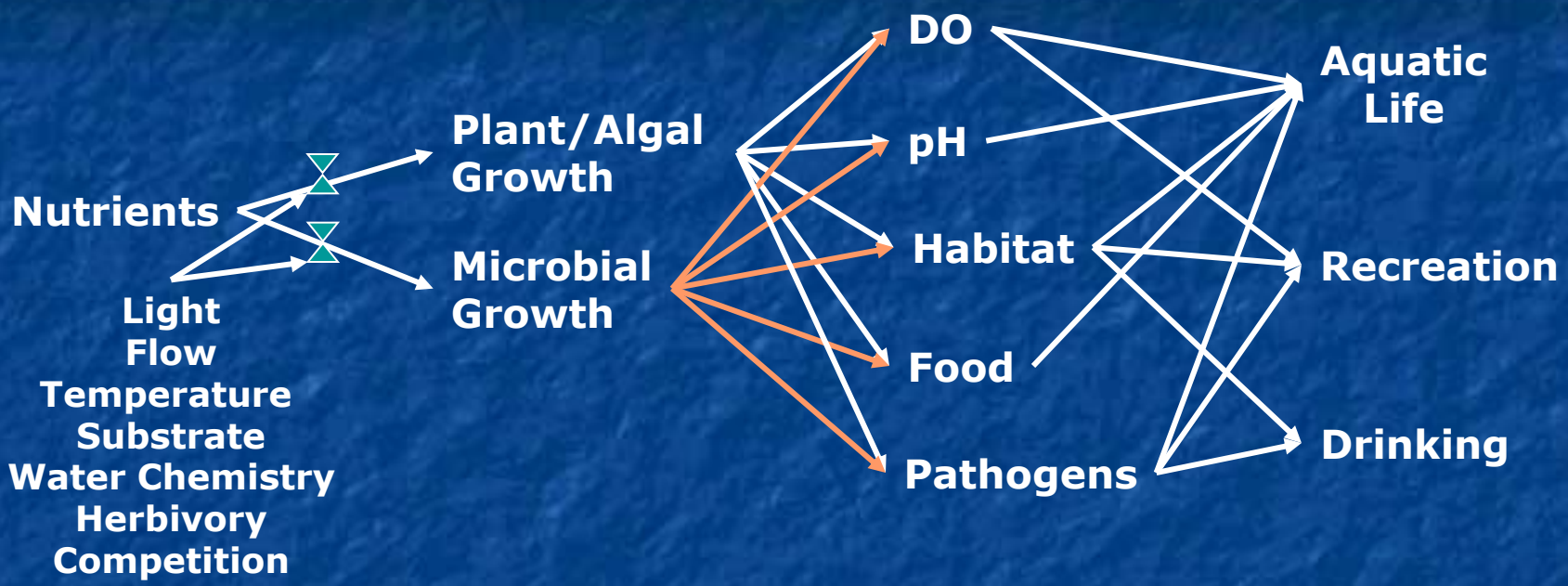
Not Chemical but Biological or Functional

- More Restrictive Site-Specific Standard

Chemical - Not Biological or Functional

- Less restrictive site-specific standard,
- Ensure downstream waters are protected

Multiple Lines of Evidence



Two major outcomes from these investigations:

- More defensible regional indicators
- Specific Methods for Developing Site-specific Standards

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Establish Treatment Goals

Tier	Total Phosphorus, mg/L	Total Nitrogen, mg/L
3	Baseline	Baseline
2	1.0	no limit
1	0.1	no limit
2N	1.0	20
1N	0.1	10

Results Statewide of the Study

Four Effluent Scenarios 30 Mechanical Plants		
Costs	Total Phosphorus / Total Nitrogen	Total Phosphorus / Total Nitrogen
	1.0 / 20 ppm	0.1 / 10 ppm
Capital	139.7 M	***1,040.1 M***
O&M	4.7 M / year	5.0 M
Rate	$ 2.99 / month	$ 13.58 / month

Economic Investigations: Phase II

- Quantify the Cost of Excess Nutrients to: Fishing, Boating, Swimming, Duck hunting, Tourism, etc.
- Quantify the Cost of Excess Nutrients in Drinking Water Treatment
- Quantify the Effect of Excess Nutrients on Livability, Property Values, Social Well-Being , etc.

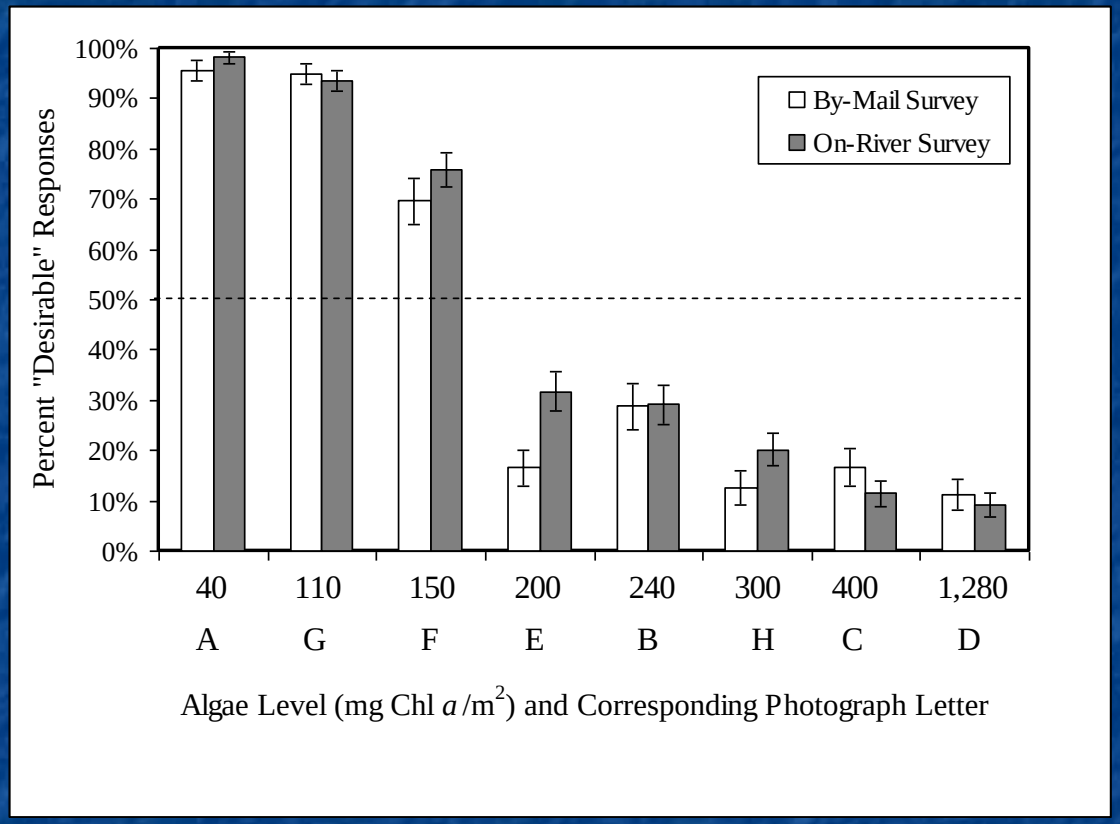
Goal: The net costs and benefits of nutrient control

How important is water quality?

- Two surveys are in the mail
- Data will be used in several economic models to quantify the economic impacts of cultural eutrophication under current and future scenarios.

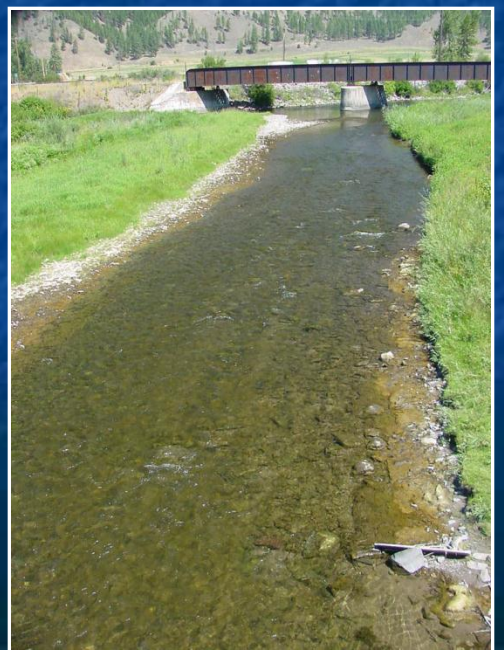
Collaboration with: M. Kealy (CH2MHill), P. Jakus (USU), N. Nielson (UWYO), and J. Loomis (CSU)

How are Recreation Uses Influenced by the Effects of N & P pollution?



How green is too green?

Linking opinions to nutrients through chl-a measures.



Suplee et al., *Journal of the American Water Resources Association* (February, 2009).

Implementation Considerations

Antidegradation

- Level II reviews are required for all new facilities or for an increase to an existing facility.
- Evaluate all alternatives and select the "least degrading" alternative that is "feasible"
- Define "feasible" via economic studies
- Consider nutrients to be of primary concern to identify the "least degrading" treatment option

Implementation Considerations

Seeking Equitable Solutions

- Level II Monitoring and Assessment will also quantify sources.
- If nutrient-related problems are identified, then identify the most cost-effective reduction.
- Implement reductions equitably where bang:buck is greatest
- Pollution trading?

Engage Stakeholders

Both Decisions and Solutions

- Listen to stakeholder concerns
- Identify potential solutions
- Revise approaches to ensure nutrient approaches are both effective and reasonable

"Opinion is the medium between knowledge and ignorance."
-Plato

quag·mire **Noun/ˈkwagˌmī(ə)r/**

1. A soft boggy area of land that gives way underfoot.
2. An awkward, complex, or hazardous situation: "a legal quagmire"

Can we avoid getting stuck by working together toward reasonable solutions to nutrient-related water quality programs?

Thanks!

Funding

- USEPA
- Utah Water Quality Board

Technical Collaborators

Baker, M. (USU)
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Discussion

Potential Improvements